CHAPTER 3—THE CONSTRUCTION OF S&E RESEARCH SPACE

HIGHLIGHTS

- In fiscal years 1996 and 1997, research-performing institutions began construction on 11.1 million net assignable square feet of science and engineering research space. This space is 17 percent more than was started in 1994 and 1995 (9.5 million NASF) (table 3-1).
- Research-performing institutions committed $3.1 billion to the construction of new S&E research facilities in fiscal years 1996 and 1997. This is 15 percent more (in constant dollars) than they committed to new construction a decade ago (table 3-2).
- Almost one third (30 percent) of all research-performing colleges and universities initiated new S&E research space construction projects during fiscal years 1996 and 1997 (table 3-5).
- Four fields account for more than half (61 percent) of the $3.1 billion committed to the construction of new research facilities in 1996 and 1997. These fields are the medical sciences in medical schools ($784 million), the biological sciences outside medical schools ($404 million), the physical sciences ($381 million), and engineering ($332 million) (table 3-8).
- For fiscal years 1998 and 1999, research-performing institutions are scheduled to commit $3.9 billion to construct S&E research facilities and one tenth of that amount ($396 million) to construct central campus infrastructure (table 3-4).

INTRODUCTION

This chapter discusses the state of recently initiated construction of new science and engineering research facilities in research-performing colleges and universities. The term "construction" in this chapter and throughout this report refers to the building of facilities that currently do not exist.

Institutions were asked to estimate the research-related costs and space for construction projects costing over $100,000 begun during fiscal years 1996 and 1997, and to make the same estimates for projects scheduled for fiscal years 1998 and 1999. Project start-up was defined as the fiscal year in which construction began or was expected to begin. In the case of multiyear projects, total project costs were allocated to the fiscal year in which the construction began. Note, however, that the costs and parameters of multiyear projects can change between the time a project begins and the time it is completed.

The reported financial commitments, defined as the costs to complete a project, include planning, site preparation, construction, fixed equipment, and building infrastructure. It should be noted that fluctuations in funds committed to construction from one year to another can result from large projects at a small number of institutions. Given the costs of constructing S&E research facilities, a large increase could reflect a new building on one or two campuses. Indeed, this is often the case for the nondoctorate-granting institutions.

Institutions were also asked to report planned expenditures for central campus infrastructure (see Item 6 of the survey in Appendix C). Central campus infrastructure was defined as those systems that exist between the buildings of a campus and the nonarchitectural elements of campus design. Examples included central wiring for telecommunications systems, waste storage and disposal facilities, electrical wiring between buildings, central heating and air exchange systems, drains, sewers, roadways, walkways, and parking systems. Plumbing, lighting, wiring, air exchange systems, and the like that exist within a building or within five feet of the building foundation were considered building infrastructure and were excluded from this definition of central campus infrastructure.

In 1998, for the first time, institutions were asked to list separately any nonfixed equipment costing $1 million or more that was included as part of their new construction costs for fiscal years 1996 and 1997. If a project were to

serve both research and nonresearch purposes, respondents were asked to prorate the construction costs and space estimates so that the research-related portion of the costs was reflected (see Items 4a, 4b, and 4c of the survey in Appendix C).

Findings

Amount of New S&E Research Space Under Construction

New construction projects initiated in 1996 and 1997 are expected to produce 11.1 million net assignable square feet of new science and engineering research space. This is a 17-percent increase in new research space under construction compared with new construction projects begun in 1994 and 1995 (9.5 million NASF) (table 3-1). These 11.1 million NASF are the equivalent of 8 percent of existing research space (143.3 million NASF).

Doctorate-granting institutions initiated the greatest amount of square footage of new facilities construction, 89 percent or 9.9 million NASF. This square footage is a 12-percent increase over 1994–95 levels (8.8 million NASF). The top 100 institutions account for 70 percent (6.9 million NASF) of the new construction projects begun at doctorate-granting institutions.

Funds Committed to the Construction of S&E Research Space

Research-performing institutions committed $3.1 billion to the construction of S&E research space in 1996 and 1997. This is 15 percent or $399 million more (in constant dollars) than they committed to new construction a decade ago (table 3-2; figure 3-1).

The doctorate-granting institutions committed more funds to new construction in 1996 and 1997 than they did a decade ago, with the largest increases occurring at the other doctorate-granting institutions. Between 1986–87 and 1996–97:

- Doctorate-granting institutions committed $348 million or 14 percent more funds to new construction;
  - Top 100 institutions committed $59 million or 3 percent fewer funds; and
  - Other doctorate-granting institutions committed $408 million or 107 percent more funds.

Table 3-1. Trends in the amount of science and engineering research space under construction for projects costing more than $100,000 by institution type: 1986–97

Institution type	1986–87	1988–89	1990–91	1992–93	1994–95	1996–97
	NASF in thousands					
Total	9,922	10,647	11,433	12,405	9,521	11,101
Doctorate-granting	8,908	9,840	11,022	12,014	8,818	9,914
Top 100 in research expenditures	7,261	6,073	6,972	8,197	6,426	6,944
Other	1,647	3,767	4,050	3,818	2,391	2,970
Nondoctorate-granting	1,014	807	411	391	703	1,187

KEY: NASF = net assignable square feet.

NOTE: Components may not add to totals due to rounding. The reader is cautioned against summing the NASF constructed over time or adding the amount of newly constructed space to existing space. The data collected do not indicate whether newly constructed space replaces existing NASF or whether new space provides additional S&E resources for the institution.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

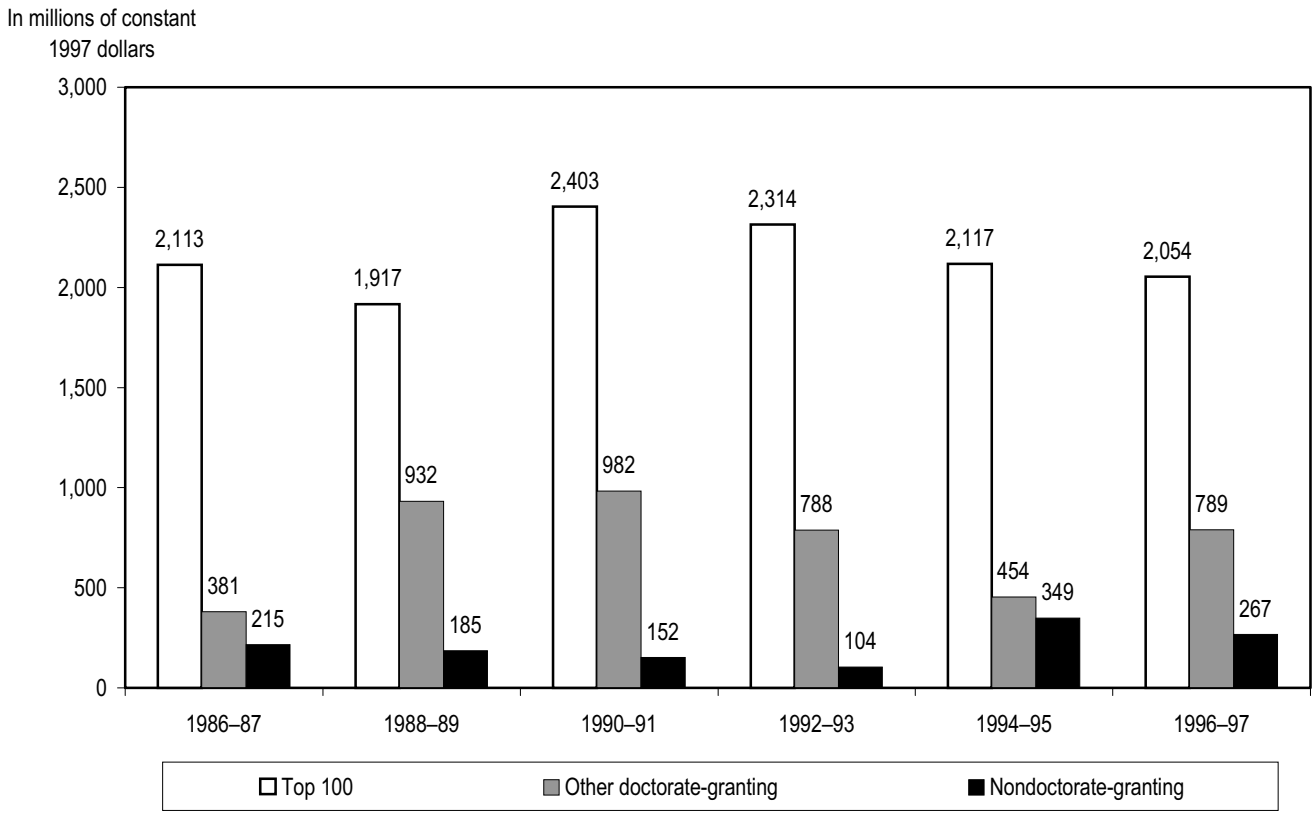
Table 3-2. Trends in funds committed to construct science and engineering research facilities for projects costing more than $100,000 by institution type: 1986–97

Institution type	1986–87	1988–89	1990–91	1992–93	1994–95	1996–97
	In millions of constant 1997 dollars					
Total	2,711	3,032	3,537	3,207	2,920	3,110
Doctorate-granting	2,495	2,849	3,383	3,102	2,571	2,843
Top 100 in research expenditures	2,113	1,917	2,403	2,314	2,117	2,054
Other	381	932	982	788	454	789
Nondoctorate-granting	215	185	152	104	349	267

NOTE: Components may not add to totals due to rounding. Current dollars have been adjusted to constant 1997 dollars using the Bureau of the Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universitites.

Figure 3-1. Trends in science and engineering construction expenditures by type of institution: 1986–97



NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Overall, in 1996 and 1997, a subset of 383 research-performing institutions that were in both the 1996 and 1998 samples committed close to what, in the 1996 survey, they anticipated committing to new construction projects in 1996 or 1997 (table 3-3).[17] They were scheduled to commit $2,828 million and actually committed $2,801 million, a difference of $27 million or 1 percent. The doctorate-granting institutions were most consistent with their earlier plans:

- Doctorate-granting institutions committed $44 million or 2 percent fewer funds than they had scheduled;
  - The top 100 institutions committed $23 million or 1 percent fewer funds than they had scheduled; and
  - Other doctorate-granting institutions committed $21 million or 3 percent fewer funds than they had scheduled.

Table 3-3. Scheduled and actual construction expenditures for projects costing more than $100,000 for science and engineering research space by institution type: 1996–97

Institution type	Number of institutions	1996–97 (scheduled)	1996–97 (actual)
		In millions of dollars	
Total	383	2,828	2,801
Doctorate-granting	257	2,726	2,682
Top 100 in research expenditures	99	2,077	2,054
Other	158	649	628
Nondoctorate-granting	126	103	119

NOTE: Components may not add to totals due to rounding. Includes only institutions that were in both the 1996 and 1998 samples.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1996 and 1998 Surveys of Scientific and Engineering Research Facilities at Colleges and Universities.

Funds Scheduled for the Construction of S&E Research Space and Central Campus Infrastructure

For fiscal years 1998 and 1999, research-performing institutions are scheduled to commit $3.9 billion to begin construction on new S&E research space. If all this construction were to occur, it would represent a 27-percent ($839 million) increase over the amount the research-performing institutions committed to new S&E construction begun in 1996 or 1997 ($3.1 billion).

This anticipated increase is greater in relative terms among nondoctorate-granting institutions than among the different types of doctorate-granting institutions. Anticipated increases in financial commitments to new S&E construction projects between the current survey period and the next are as follows:

- Doctorate-granting institutions plan to commit 23 percent or $651 million more to new S&E construction projects in 1998 and 1999 than they did in 1996 and 1997;
  - Top 100 institutions plan to commit 24 percent or $483 million more;
  - Other doctorate-granting institutions plan to commit 21 percent or $168 million more; and
- Nondoctorate-granting institutions plan to commit 70 percent or $188 million more to new S&E construction projects (tables 3-4 and 3-2).

Research-performing institutions are scheduled to commit another $396 million to new central campus infrastructure construction projects in 1998 and 1999. These funds are distributed among the institution types as follows:

- Doctorate-granting institutions plan to commit 91 percent or $359 million of all new central campus infrastructure funds;
  - Top 100 institutions plan to commit 75 percent or $297 million of these funds;
  - Other doctorate-granting institutions plan to commit 16 percent or $62 million of these funds; and

[17] The scheduled 1996–97 data come from National Science Foundation/Division of Science Resources Studies, *1996 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.* Because this analysis is limited to the subset of research-performing institutions that were in both the 1996 and 1998 samples, the results do not generalize to the population of research-performing institutions.

- Nondoctorate-granting institutions plan to commit 9 percent or $37 million of these funds.

Colleges and Universities Starting S&E Construction Projects

In fiscal years 1996 and 1997, 30 percent of all research-performing institutions initiated new S&E construction projects. This proportion is less than in fiscal years 1986–87 through 1992–93 when a larger proportion of institutions started new S&E construction projects.

A larger proportion of doctorate-granting institutions began S&E construction in these years than began construction projects in 1996 and 1997 (38 percent). The proportion of nondoctorate-granting institutions starting new S&E construction projects in fiscal years 1996 and 1997 (19 percent) is not appreciably different from any year except 1988–89, when 32 percent of nondoctorate-granting institutions started new S&E construction projects (table 3-5).

In 1998 and 1999, 31 percent of research-performing institutions are scheduled to start new S&E construction projects. Only the top 100 institutions anticipated a change in the percentage of institutions scheduled to start new S&E construction projects. If the top 100 institutions act in accordance with their plans, 64 percent of them will start new construction projects in 1998 and 1999. This represents a 4-percentage point drop from 1996 and 1997 when 68 percent of these institutions started new projects.

A separate analysis (table 3-6) of the 383 institutions that were in both the 1996 and 1998 samples reveals that 104 or 71 percent of all research-performing institutions that had scheduled new construction for 1996 or 1997 actually undertook it.[18] The actions of the top 100 institutions were more consistent with their plans than that of the other types of institutions. Overall, 91 or 74 percent of all doctorate-granting institutions that had scheduled construction acted in accordance with their plans, as did:

- 55 or 89 percent of top 100 institutions;
- 36 or 59 percent of other doctorate-granting institutions; and
- 14 or 58 percent of nondoctorate-granting institutions.

[18] Because this analysis is limited to the subset of research-performing institutions that were in both the 1996 and 1998 samples, the results do not generalize to the population of research-performing institutions.

Table 3-4. Funds scheduled for construction of science and engineering (S&E) research space and central campus infrastructure for projects costing more than $100,000 by institution type: 1998–99

Institution type	Scheduled construction		
	S&E research space	Central campus infrastructure	Total*
	In millions of dollars		
Total	3,949	396	4,344
Doctorate-granting	3,494	359	3,853
Top 100 in research expenditures	2,537	297	2,834
Other	957	62	1,019
Nondoctorate-granting	455	37	492

*This is the total of scheduled S&E research space and central campus infrastructure construction. It does not represent total scheduled construction across all science and nonscience disciplines.

NOTE: Components may not add to totals due to rounding.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Table 3-5. Trends in the percentage of institutions starting projects to construct science and engineering research facilities costing more than $100,000 by institution type: 1986–99

Institution type	1986–87	1988–89	1990–91	1992–93	1994–95	1996–97	(scheduled) 1998–99
	Percentage						
Total	37	44	37	33	29	30	31
Doctorate-granting	47	53	57	44	42	38	38
Top 100 in research expenditures	72	71	81	79	75	68	64
Other	34	44	45	28	26	27	29
Nondoctorate-granting	25	32	12	15	13	19	21

NOTE: As used here, capital projects are construction projects with prorated costs of $100,000 or more for affected research space.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

Table 3-6. Number of institutions starting science and engineering research facilities construction projects costing more than $100,000 and whether construction was scheduled by institution type: 1996–97

Institution type	Number of institutions that scheduled construction	Number of institutions that scheduled construction and actually started construction	Number of institutions that did not schedule construction	Number of institutions that did not schedule construction but started construction
Total	147	104	236	29
Doctorate-granting	123	91	134	28
Top 100 in research expenditures	62	55	37	13
Other	61	36	97	15
Nondoctorate-granting	24	14	103	1

NOTE: Components may not sum to totals due to rounding. Includes only 383 institutions that were in both the 1996 and 1998 samples.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1996 and 1998 Surveys of Scientific and Engineering Research Facilities at Colleges and Universities.

It is also worth noting that 29 or 12 percent of institutions that had not scheduled construction for 1996 or 1997, did, in fact, start new construction projects during that period. Overall, 28 or 21 percent of doctorate-granting institutions that had not scheduled any construction projects began construction projects; 13 or 35 percent of the top 100 institutions that had not scheduled construction projects did so.

Fields In Which Construction Projects Started

Overall, the proportion of institutions that began new S&E construction projects declined by 7-percentage points over the decade, from 37 to 30 percent of institutions. Two fields registered an appreciable change during this time period:

- In engineering, the proportion of institutions starting new construction projects decreased from 28 to 11 percent; and
- In the agricultural sciences, the proportion of institutions starting new construction projects decreased from 38 to 28 percent (table 3-7).

Only one field registered an appreciable increase in the proportion of institutions starting new construction since the last survey period. The proportion of institutions starting new construction projects in the biological sciences outside medical schools increased from 9 percent of institutions to 13 percent.

Finally, the proportion of institutions scheduled to start new construction projects in the various S&E fields in 1998 and 1999 is expected to decline appreciably from 1996–97 levels in one field. The proportion of institutions scheduled to start new construction projects in the medical sciences in medical schools is expected to decrease from 33 to 20 percent of institutions.

Funds Committed to S&E Research Space Construction Projects in Different Fields

Four fields account for more than half (61 percent) of the $3.1 billion committed to the construction of new S&E research space by research-performing institutions in fiscal years 1996 and 1997:

- The medical sciences in medical schools account for $784 million;
- The biological sciences outside medical schools account for $404 million;

Table 3-7. Trends in the percentage of institutions starting projects to construct science and engineering research facilities costing more than $100,000 by field: 1986–99

Field	1986–87	1988–89	1990–91	1992–93	1994–95[1]	1996–97	(scheduled) 1998–99
	Percentage						
Total	37	44	37	33	29	30	31
Biological sciences—							
inside medical schools	20	26	33	20	10	14	22
outside medical schools	9	19	10	10	8	13	12
Physical sciences	9	15	11	9	9	11	14
Psychology	5	3	7	2	2	4	5
Social sciences	5	4	--[2]	3	4	5	4
Mathematics	1	2	4	2	1	1	5
Computer sciences	8	6	7	4	1	4	3
Earth, atmospheric, and							
ocean sciences	9	6	15	9	5	11	9
Engineering	28	18	16	17	14	11	14
Agricultural sciences	38	33	30	27	23	28	20
Medical sciences—							
inside medical schools	32	23	41	33	26	33	20
outside medical schools	7	5	13	11	6	9	11

[1] Some 1994–95 values have been revised from the 1996 report.

[2] Psychology and the social sciences were not differentiated in the questionnaire item for the 1990–91 period.

NOTE: Percentages are based on the number of institutions with existing research space and/or planned construction of research space in a given field.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- The physical sciences account for $381 million; and
- Engineering accounts for $332 million (table 3-8).

In addition to these four fields, research-performing institutions committed more than $100 million to construct new research space in five other fields:

- The agricultural sciences account for $273 million;
- The medical sciences outside of medical schools account for $259 million;
- The biological sciences in medical schools account for $178 million;
- The earth, atmospheric, and ocean sciences account for $172 million; and
- The other sciences account for $145 million.

The amount of funds committed to the construction of new research space more than doubled in three fields since the last survey:

- In the earth, atmospheric, and ocean sciences, funds increased from $35 million to $172 million (a 391-percent increase);
- In mathematics, funds increased from $2 million to $9 million (a 350-percent increase); and
- In the medical sciences outside medical schools, funds increased from $129 million to $259 million (a 101-percent increase).

The amount of funds committed for the construction of new research space declined by 25 percent or more in three fields since the last survey:

- In the computer sciences, from $49 million to $21 million (a 57-percent decrease);

Table 3-8. Trends in funds committed to construct science and engineering research facilities for projects costing more than $100,000 by field: 1986–99

Field	1986–87	1988–89	1990–91	1992–93	1994–95	1996–97	(scheduled) 1998–99
	In millions of constant 1997 dollars						
Total	2,711	3,032	3,537	3,207	2,920	3,110	3,949
Biological sciences—							
inside medical schools	184	223	453	389	238	178	597
outside medical schools	428	487	536	333	409	404	812
Physical sciences	241	494	511	384	449	381	525
Psychology	31	31	43	18	44	77	91
Social sciences	51	59	-- *	51	118	75	81
Mathematics	2	11	15	12	2	9	19
Computer sciences	81	80	47	54	49	21	27
Earth, atmospheric, and							
ocean sciences	75	100	202	140	35	172	235
Engineering	568	478	469	326	607	332	528
Agricultural sciences	198	187	208	239	158	273	169
Medical sciences—							
inside medical schools	399	722	779	957	554	784	613
outside medical schools	268	75	179	183	129	259	206
Other sciences	184	87	95	117	129	145	46

* Psychology and the social sciences were not differentiated in the questionnaire item for the 1990–91 period.

NOTE: Components may not add to totals due to rounding. Current dollars have been adjusted to constant 1997 dollars using the Bureau of the Census' Composite Fixed-Weighted Price Index for Construction.

SOURCE: National Science Foundation/Division of Science Resources Studies, 1998 Survey of Scientific and Engineering Research Facilities at Colleges and Universities.

- In engineering, from $607 million to $332 million (a 45-percent decrease); and
- In the biological sciences in medical schools from $238 million to $178 million (a 25-percent decrease).

In 1998 and 1999, funds committed to new construction are scheduled to more than double in three fields:

- In the biological sciences in medical schools, funds are expected to increase from $178 million to $597 million (a 235-percent increase);
- In mathematics, funds are expected to increase from $9 million to $19 million (a 111-percent increase); and
- In the biological sciences outside medical schools, funds are expected to increase from $404 million to $812 million (a 101-percent increase).

At the same time, funds committed to new construction are scheduled to decrease by at least 20 percent in four fields:

- In other sciences, from $145 million to $46 million (a 68-percent decrease);
- In the agricultural sciences, from $273 million to $169 million (a 38-percent decrease);
- In the medical sciences in medical schools, from $784 million to $613 million (a 22-percent decrease); and
- In medical sciences outside medical schools, from $259 million to $206 million (a 20-percent decrease).

Funds Committed to Nonfixed Equipment Costing Over $1 Million in New Construction Projects

In 1996 and 1997, 10 doctorate-granting institutions (4 top 100 institutions and 6 other doctorate-granting institutions) committed $18.9 million to nonfixed equipment costing $1 million or more in their new S&E construction projects. These commitments occurred in only four fields and represented 11 percent of total construction commitments in those fields:

- In the biological sciences outside medical schools, the amount of funds committed by two institutions to nonfixed equipment costing over $1 million accounted for 8 percent of all construction commitments in this field;
- In the physical sciences, the amount of funds committed by three institutions to this type of equipment accounted for 9 percent of all construction commitments in this field;
- In engineering, the amount of funds committed by two institutions to this type of equipment accounted for 17 percent of all construction commitments in this field; and
- In the medical sciences outside medical schools, the amount of funds committed by two institutions to this type of equipment accounted for 15 percent of all construction commitments in this field.